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Journal of Alloys and Compounds 387 (2005) 70–73

Journal of ALLOYS AND COMPOUNDS

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Mössbauer effect and electrical properties studies of $SmFe_xMn_{1-x}O_3$ (x = 0.7, 0.8 and 0.9)

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Received 2 June 2004; received in revised form 26 June 2004; accepted 29 June 2004

Abstract

The cation distributions in the B-site of the orthoferrites $SmFe_xMn_{1-x}O_3$ (x = 0.7, 0.8, 0.9) were studied by ^{57}Fe Mössbauer spectroscopy at room temperature. The spectra showed several nonequivalent sites of the iron ions. Five sextets were used in the fitting of the experimentally observed spectra and each one corresponds to different number of the Fe ions in the next nearest neighboring. A nonrandom cation distribution model in such compounds was proposed to interpret the multi-sextets spectra.

According to the electric properties measurements, it was noted that the conductivity increases two times with increasing the Mn content but the activation energy decreases from 0.34 eV down to 0.22 eV. The sample with x = 0.7 is an electron semiconductor while the other samples display hole conduction. The magnetoresistance MR of the studied samples value is of 10% and has a negative sign at room temperature while a positive sign is obtained with temperature raising.

Keywords: Nonrandom; Cation; Distribution; Perovskites; Mössbauer

1. Introduction

The scientific interest during the last few decades has been devoted to studying the orthoferrites and related compounds because of their important technological applications and unusual magnetic and electrical properties. The orthoferrites $RFeO_3$ (R is the rare earth element) have a distorted perovskite crystal structure. R occupies the lattice site A while the transition metal occupies the lattice site B [1]. All the transition metal elements are in the corners and are surrounded by oxygen anions forming octahedra. These orthoferrites are antiferromagnetic insulators. The magnetic interactions in such cases are formed as a result of the strong negative indirect Fe^{3+}–O–Fe^{3+} interaction, which causes the formation of two magnetic sublattices whose moments are almost antiparallel [2]. The small angle between these sublattices moments leads to appearance of a weak ferromagnetic moment [3].

The magnetic properties of the materials which have crystallographically-inequivalent cation sites often depend on the relative population of the sites or the cation distribution. If the cations are randomly distributed, it can be described as a binomial distribution [4]. Mössbauer spectroscopy is a powerful tool for studying relative site populations that are occupied by Fe ions.

The problem in the present paper is to determine the different distributions of the Fe and Mn atoms of the B-sites in the next nearest neighbor shell and the correlation between such distributions and the resulting magnetic interactions. The conductivity, magnetoresistance and thermoelectric power were investigated for the same samples.

2. Experimental details

The $SmFe_{1-x}Mn_xO_3$ samples were doped with ^{57}Fe. They were prepared by standard ceramic procedures and have perovskite-like structure. The Mössbauer spectra were mea-

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doi:10.1016/j.jallcom.2004.06.070